CLEANING SHEET

Background of the Invention

The present invention relates to a cleaning sheet which is particularly suited for cleaning a kitchen and places where water is used, such as a bathroom.

JP-A-4-136252 discloses abrasive nonwoven fabric made of core-sheath type conjugate fibers having abrasive particles in the sheath thereof. Although the abrasive nonwoven fabric feels good and exhibits long-lasting abrasive effect, the abrasive particles are liable to sink in the fibers, sometimes failing to show sufficient dirt scraping properties. Further, the abrasive particles may come off during cleaning unless they are firmly bonded to the fibers.

WO97/21865 proposes single layer abrasive nonwoven fabric having a first abrasive plane formed of abrasive fiber pieces which are shaped into spheres and having the abrasive fiber pieces distributed with a concentration gradient in the thickness direction thereof. The proposed nonwoven fabric is for use as a dry or wet duster or towel for removing dust, fats and oils. The abrasive fiber pieces are formed by thermal shrinkage of thermoplastic fibers having a fiber length of up to about 15 mm, and those having a particle diameter of 100 μm or greater allegedly exhibit an abrasive action. However, the fiber pieces which are shaped into spheres, having substantially no form of fiber, are incompetent for scraping off caked-on soils without fail.

JP-A-2000-328415 discloses short fiber nonwoven fabric made of thermally-bonding conjugate fibers having a fineness of 30 to 80 denier and a length of 3 to 40 mm, which was developed for the purpose of obtaining nonwoven fabric having a high compressive recovery and a high rate of liquid permeation for use in absorbent articles, such as disposable diapers, sanitary napkins, and absorbent dusters or sheets. It is not aimed at to scour or scrape dirt off the surface of an object to be cleaned. Containing no cellulosic fiber, the nonwoven fabric is incapable of uniform impregnation with an aqueous detergent and has poor dirty liquid retentive properties after scraping off soils.

Cleansing articles, for example, a brush made of a metal and a sponge with abrasive particles such as aluminum oxide are commercially available. These cleansing articles, however, unfavorably make a scratch on a surface to be cleaned.

Summary of the Invention

An object of the present invention is to provide a cleaning sheet which does not contain abrasive particles and yet exhibits sufficient scouring or scraping properties against soils.

Another object of the present invention is to provide a cleaning sheet which is capable of removing caked-on soils, such as denatured oil, baked-on substances, and scale (incrustations) in a kitchen or soap scum and scale found in a bathroom.

Still another object of the present invention is to provide a cleaning sheet which does not make a scratch on a surface to be cleaned, for example, in a kitchen and a bathroom, made of stainless, artificial marble, fluorine resin, tiles and enamel.

The above objects are accomplished by a cleaning sheet which comprises 10 to 90% by weight of thermoplastic fibers having a fiber length of 2 to 15 mm and a fineness of 10 to 150 dtex and 10 to 90% by weight of cellulosic fibers, and has a large number of tips of said thermoplastic fibers exposed on the surface of said cleaning sheet to have capability of scouring or scraping dirt off present on a soiled surface. The cleaning sheet according to the present invention can be used conveniently as combined with water or a house cleaner or as impregnated with water or an aqueous detergent to remove caked-on soils from a soiled surface of an object.

Brief Description of the Drawings

The present invention will be more particularly described with reference to the accompanying drawings, in which:

Fig. 1 is a schematic cross-sectional view of a cleaning sheet according to an embodiment of the present invention;

Fig. 2 is a schematic cross-sectional view of a cleaning sheet according to another embodiment of the present invention;

Fig. 3 is a schematic perspective view of the cleaning sheet shown in Fig. 2;

Fig. 4 is a schematic cross-sectional view of a cleaning sheet according to still another embodiment of the present invention (corresponding to Fig. 1);

Fig. 5 is a schematic cross-sectional view of a cleaning sheet according to yet another embodiment of the present invention (corresponding to Fig. 1); and

Fig. 6 is an example of a heat embossed pattern.

Detailed Description of the Preferred Embodiments

The present invention will be described with particular reference to its preferred embodiments along the accompanying drawings, in which Fig. 1 is a schematic cross-sectional view of a cleaning sheet 1 according to an embodiment of the present invention.

The cleaning sheet 1 according to the embodiment shown in Fig. 1 is an air-laid nonwoven fabric formed by air-laying fibers into a web and bonding the constituent fibers at their intersections. The cleaning sheet 1 comprises thermoplastic fibers 2 and cellulosic fibers 3.

The thermoplastic fibers 2 which can be used in the present invention have a fiber length of 2 to 15 mm and a fineness of 10 to 150 dtex which will hereinafter be referred to as thick thermoplastic fibers. Since the thick thermoplastic fibers have such a short fiber length of 2 to 15mm and a thick fineness 10 to 150 dtex, a large number of their tips are exposed on the cleaning surface of the sheet 1 and the individual thick thermoplastic fiber becomes hard to bend thereby to exhibit high scouring or scraping properties for removing soils from a soiled surface of an object.

Thermoplastic fibers shorter than 2 mm are liable to fall off the sheet 1, and the sheet comprising such short thermoplastic fibers has reduced scraping properties. Thermoplastic fibers longer than 15 mm will be entangled among themselves before passing through a screen in web formation by an air-lay method, making it difficult to prepare a uniform web. Where the thick thermoplastic fibers 2 have a length of 3 to 8 mm, particularly 4 to 6 mm, they are prevented from falling off the sheet 1 more effectively, and a fiber web having more uniformity and enhanced scraping properties

can be formed.

If the fineness of the thick thermoplastic fibers 2 is less than 10 dtex, the properties of scraping off caked-on soils (denatured oil, baked substances, scale, etc.) are insufficient. Too thick thermoplastic fibers thicker than 150 dtex are difficult to make into uniform nonwoven fabric and also result in a high basis weight, which unfavorably increases the production cost. Where the thick thermoplastic fibers 2 have a fineness of 20 to 130 dtex, preferably 30 to 120 dtex, still preferably 40 to 110 dtex, the resulting sheet 1 shows particularly excellent properties of scraping off tenacious soils, for example, baked-on soils on cookware.

It is preferred for the cellulosic fibers 3 to have a fiber length of 0.1 to 15 mm for ease of forming a uniform web by an air-lay method. When a fiber web is prepared by a method other than an air-lay method, the fiber length of the cellulosic fibers 3 is not particularly limited. In using, as cellulosic fiber 3, wood pulp, which generally has a broad fiber length distribution, fibers having a length-weighted average fiber length of 1 to 4 mm are used suitably. A length-weighted average fiber length of wood pulp can be measured with, for example, a Kajaani fiber length analyzer and represented by the following equation:

$$\text{Length - Weighed Average Fiber Length} = \frac{\sum N_i (l_i)^2}{\sum N_i l_i}$$

wherein l_i (i = 1 to 144) is an average length of fibers whose lengths are within a very narrow specific range ; and N_i is the number of the fibers.

The fineness of the cellulosic fibers 3 is not particularly limited and is selected appropriately according to the kind of the fiber.

The content of the thick thermoplastic fibers 2 is 10 to 90% by weight, preferably 30 to 90% by weight. A thick thermoplastic fiber 2 content less than 10% by weight results in poor scraping properties due to a reduced amount of the thick thermoplastic fibers 2 present on the surface of the sheet 1. A content more than 90% by weight results in improved scraping properties but makes it difficult for the sheet 1 to

be impregnated with an aqueous detergent and to absorb dirty liquid after scraping off dirt.

The content of the cellulosic fiber 3 in the cleaning sheet 1 is 10 to 90% by weight, preferably 10 to 70% by weight. A cellulosic fiber 3 content less than 10% by weight results in difficulty in infiltrating an aqueous detergent uniformly and reduction in dirty liquid absorptivity after scraping off dirt. If the content is more than 90% by weight, the proportion of the thick thermoplastic fiber is insufficient for securing scraping properties against caked-on soils.

The thick thermoplastic fiber 2 includes fibers of polyolefin resins such as polyethylene and polypropylene, polyester resins such as polyethylene terephthalate, acrylic resins such as polyacrylic acid and polymethacrylic acid, vinyl resins such as polyvinyl chloride, polyamide resins such as nylon, various metals, glass, and the like. In using resin fibers, the resin hardness is preferably in a range of from R40 to R150 in terms of Rockwell hardness. Resins having a Rockwell hardness of R80 to R150 are particularly preferred for securing scraping properties. Conjugate fibers, such as core/sheath type or side-by-side type, made of two kinds selected from the above-recited resins are also useful. Preferred of the above-described fiber materials are acrylic fibers, polyester fibers, polyvinyl chloride fibers, polyamide fibers and polyolefin fibers for their excellent scraping properties without scratching an object to be cleaned, such as stainless steel, tiles, enamel and artificial marble. For preventing fall-off from the sheet 1, it is suitable to use heat-fusible conjugate fibers composed of a low-melting resin and a high-melting resin, the low-melting resin forming at least a part of the fiber surface. Examples of suitable combinations of low-melting resin/high-melting resin are high density polyethylene/polypropylene, low density polyethylene/polypropylene, polypropylene/ethylene-butene-1 crystalline copolymer, high density polyethylene/polyethylene terephthalate, nylon-6/nylon-66, low-melting polyester/polyethylene terephthalate, and polypropylene/polyethylene terephthalate.

The configurations of the heat-fusible conjugate fibers include a side-by-side structure, a concentric core/sheath structure, an eccentric core/sheath structure, a multilayer structure having three or more layers, a hollow side-by-side structure, a sectional core/sheath structure, and an islands-in-sea structure, in which a low-melting

resin forms at least a part of the fiber surface. Preferred of the heat-fusible conjugate fibers are side-by-side, concentric core/sheath or eccentric core/sheath type conjugate fibers composed of at least one thermoplastic resin selected from high density polyethylene, linear low density polyethylene, an ethylene-butylene-1 crystalline copolymer, and a low-melting polyester, e.g., a copolyester of polyethylene terephthalate and polyethylene isophthalate, as a low-melting resin , and polypropylene or polyethylene terephthalate as a high-melting resin. Conjugate fiber composed of a low-melting polyester and polyethylene terephthalate is particularly preferred for obtaining excellent scraping properties.

Crimping fiber is also used as thick thermoplastic fiber 2 to improve bulkiness and thereby the feel on use of the cleaning sheet 1. Any crimping form, such as a spiral form, a zig-zag form, and a U-form, can be used suitably.

Two or more kinds of thick thermoplastic fibers 2 can be used in combination. In such a case, two or more kinds of thick thermoplastic fibers of which the lengths and the finenesses fall within the above-described respective ranges are used in a total amount within the above-specified thick thermoplastic resin content.

The cellulosic fiber 3 includes wood pulp fiber, flax fiber, cotton fiber, and regenerated fibers such as rayon. In particular, soft wood pulp fiber or cotton or rayon fiber having a fiber length of about 0.1 to 15 mm hardly falls off and exhibits adequate sheet strength.

Two or more kinds of the cellulosic fibers can be used in combination in a total amount within the above-specified cellulose fiber content.

The thick thermoplastic fibers 2 and the cellulosic fibers 3 are present in the cleaning sheet 1 in a uniformly mixed state. A large number of the tips of the thick thermoplastic fibers 2 are present on the cleaning surface of the cleaning sheet 1, with which soils can be scoured or scraped off effectively.

As stated above, a large number of the tips of the thick thermoplastic fibers 2 are

present on the cleaning surface of the cleaning sheet 1. The number of the tips of the thick thermoplastic fibers 2 exposed on the cleaning surface is such that the sheet 1 exhibits sufficient scouring or scraping properties against dirt on a soiled surface. Specifically, the number is preferably 20 to $4000/cm^2$, still preferably 50 to $2000/cm^2$, particularly preferably 100 to $1000/cm^2$, especially preferably 120 to $600/cm^2$.

The number of the tips of the thick thermoplastic fibers 2 present on the surface of the cleaning sheet 1 is defined as follows. The term "(clcaning) surface" of the cleaning sheet 1 is intended to include any surface that is contributory to scraping soils when the surface of an object to be cleaned is wiped with the sheet 1 under a strong force. Therefore, the number of the tips of the thick thermoplastic fibers 2 present on one side of the cleaning sheet 1 is defined to be the total number of the thick thermoplastic fibers 2. Accordingly, the number of the tips of the thick thermoplastic fibers 2 is obtained from the weight s (g) of a single thick thermoplastic fiber 2 and the total weight w (g/cm^2) of the thick thermoplastic fibers 2 per unit area of the sheet 1, i.e., w/s.

It is preferred for the cleaning sheet 1 to further comprise heat-fusible fiber having a fineness of about 0.5 to 5 dtex, relatively thinner than the thick thermoplastic fibers 2, in addition to the thick thermoplastic fiber 2 and the cellulosic fiber 3. Presence of such heat-fusible fiber is effective in preventing the thick thermoplastic fibers 2 from falling off and in improving scraping properties. From this viewpoint, it is desirable that the heat-fusible fibers be thermally bonded among themselves and also with the thick thermoplastic fibers 2 at the intersections. A preferred content of the heat-fusible fiber in the cleaning sheet 1 is 1 to 50% by weight, particularly 2 to 30% by weight.

The cleaning sheet 1 is formed by accumulating the thick thermoplastic fibers 2 and the cellulosic fibers 3 into a web by an air-lay method and bonding the fibers constituting the air-laid web at their intersections. Bonding the fibers is suitably achieved by fusion or with a binder. Useful binders include acrylonitrile-butadiene rubber, styrene-butadiene rubber, polyvinyl acetate, an ethylene-vinyl acetate copolymer, and polyacrylate. The cleaning sheet 1 formed by an air-lay method can have the thick thermoplastic fibers 2 randomly oriented in three dimensions so that a

great number of the tips of the thick thermoplastic fibers 2 may be exposed on the surface of the sheet 1. Having the above-specified fiber length, the thick thermoplastic fibers 2 are readily oriented in the sheet thickness direction to develop scraping properties. The above-specified fineness of the thick thermoplastic fibers 2 secures their stiffness to develop scouring or scraping properties.

From the viewpoint of convenience in wiping with the cleaning sheet 1 by hand, it is preferred for the cleaning sheet 1 to have an uneven pattern formed by embossing. Where heat-fusible fiber is used in combination, heat embossing or ultrasonic embossing to make an uneven pattern is preferred not only from the same viewpoint but for improving the sheet strength.

The cleaning sheet 1 according to the present embodiment is useful to remove caked-on soils, such as denatured oil, baked substances or scale which are sticking to stoves (cookers), countertops, cookware, sinks, etc. in a kitchen and sebum, scale, dust and soap scum which are sticking to tiles, a tub, etc. in a bathroom. It is especially suited for cleaning a kitchen. Since the cleaning sheet 1 according to the embodiment shown in Fig. 1 has a great number of tips of the thick thermoplastic fibers 2 exposed on both sides thereof, each side can serve as a cleaning surface.

The cleaning sheet 1 can be used either as a dry sheet free of liquid or a wet sheet impregnated or sprayed with liquid such as an aqueous detergent. It is especially effective to use the cleaning sheet 1 as impregnated or sprayed with liquid such as an aqueous detergent. Comprising hydrophilic cellulosic fibers 2 in a specified amount, the cleaning sheet 1 is capable of holding an adequate amount of an aqueous detergent for cleaning. When a soiled surface of an object is wiped with the cleaning sheet 1 impregnated with an aqueous detergent, the soils are swollen with or partly dissolved in the aqueous detergent so that the mechanical cleaning performance by scouring or scraping with the cleaning sheet is boosted. The cleaning sheet 1 may be supplied on the market as previously impregnated with an aqueous detergent or be sprayed with an aqueous detergent by an user on use.

The mechanism of soil rcmoval with the cleaning sheet 1 according to the

present embodiment is explained hereunder taking the aqueous detergent-impregnated wet cleaning sheet as an example. When either side of the cleaning sheet 1 is applied to a soiled surface and rubbed, the aqueous detergent in the sheet 1 is applied to the soiled surface to swell, dissolve or float the soils. At the same time, a large number of the tips of the thick thermoplastic fibers 2 present on the cleaning surface of the sheet 1 scour or scrape off the soils. The soils are removed through these chemical and mechanical actions. The dirt thus caught up is dissolved or dispersed in the aqueous detergent and absorbed by the sheet 1 together with the cleaner to make the surface clean.

The aqueous detergent which can be infiltrated into the cleaning sheet 1 or be used in combination with the sheet 1 comprises water as a medium and preferably contains a surface active agent, an alkali agent, an electrolyte and a water-soluble solvent. Incorporation of an antimicrobial agent into the aqueous detergent is preferred. The content of non-volatile residues in the aqueous detergent is preferably not more than 10% by weight, particularly 5% by weight or less, for giving a satisfactory cleaning finish.

The surface active agent which can be used in the aqueous detergent includes anionic surface active agents, nonionic surface active agents, cationic surface active agent and amphoteric surface active agents. From the standpoint of cleaning action and finish, preferred surface active agents include nonionc ones, such as polyoxyalkylene (mole number of alkylene oxide units added: 1 to 20) alkyl (straight-chain or branched, containing 8 to 22 carbon atoms) ethers, alkyl (straight-chain or branched, containing 8 to 22 carbon atoms) glycosides (average sugar condensation degree: 1 to 5), sorbitan fatty acid (straight-chain or branched, containing 8 to 22 carbon atoms) esters, and alkyl (straight-chain or branched, containing 6 to 22 carbon atoms) glycerol ethers and amphoteric ones containing 8 to 24 carbon atoms, such as alkylcarboxybetaines, alkylsulfobetaines, alkylhydroxysulfobetaines, alkylamidocarboxybetaines, alkylamidosulfobetaines, and alkylamidohydroxysulfobetaines. The surface active agent is preferably used in an amount of 0.01 to 2.0% by weight, particularly 0.05 to 1.0% by weight, based on the aqueous detergent in view of detergency and cleaning finish.

The alkali agent which can be used includes hydroxides such as sodium hydroxide, carbonates such as sodium carbonate and potassium carbonate, alkaline sulfates such as sodium hydrogensulfate, phosphates such as sodium primary phosphate, organic alkali metal salts such as sodium acetate and sodium succinate, ammonia, alkanolamines such as mono-, di- or triethanolamine, β-aminoalkanols such as 2-amino-2-methyl-1-propanol, and morpholine. Alkanolamines such as mono-, di- or triethanolamine, β-aminoalkanols such as 2-amino-2-methyl-1-propanol, and morpholine are particularly preferred for the feel and pH buffering action. The alkali agent is used in an amount of 1% by weight or less, particularly 0.5% by weight or less, based on the aqueous detergent for preventing sliminess and improving the feel. Since an alkali agent is sometimes apt to swell oily soils to make the surface to be cleaned slippery, the content in the aqueous detergent is preferably as small as is consistent with a desired effect and may be zero.

The electrolyte which can be added to the aqueous detergent includes water-soluble salts of monovalent metals, such as sodium chloride, potassium chloride and sodium sulfate; water-soluble salts of divalent metals, such as magnesium sulfate, calcium chloride and zinc sulfate; water-soluble salts of trivalent metals, such as aluminum chloride and iron chloride; and water-soluble organic acid salts, such as sodium citrate, sodium succinate, sodium tartrate, sodium lactate, and sodium fumarate. The electrolyte is preferably added in an amount of 0.01 to 10% by weight, particularly 0.04 to 5% by weight, especially 0.08 to 3% by weight, based on the aqueous detergent to improve the scraping properties and finish after cleaning.

The water-soluble solvent which can be used in the aqueous detergent includes monohydric alcohols, polyhydric alcohols, and their derivatives. From the standpoint of oily soil dissolving properties, finish, and safety, preferred of them are ethanol, isopropyl alcohol, propanol, ethylene glycol monomethyl ether, propylene glycol monomethyl ether, propylene glycol, butanediol, 3-methyl-1,3-butanediol, hexylene glycol and glycerol. Particularly, from the standpoint of providing antimicrobial performance with the detergent, preferred of them are ethanol, isopropyl alcohol and propanol. The water-soluble solvent is preferably used in an amount of 1 to 50% by weight, particularly 1 to 20% by weight, based on the aqueous detergent in view of smell and reduction in skin irritation.

The aqueous detergent can further contain an antimicrobial agent to impart an antimicrobial effect to the aqueous detergent in addition to the detergency. Useful antimicrobial agents include hydrogen peroxide, hypochloric acid, sodium hypochlorite, quaternary ammonium salts, sodium benzoate, sodium p-hydroxybenzote, and naturally occurring antimicrobials such as polylysine. Quaternary ammonium salts, sodium benzoate and polylysine are preferred for their compounding stability and antimicrobial activity. The antimicrobial agent is preferably added in an amount of 0.005 to 2% by weight, particularly 0.01 to 1% by weight, based on the aqueous detergent, taking into consideration the balance of antimicrobial effect and reduction in skin irritation.

If desired, the aqueous detergent can contain perfumes, fungicides, colorants (dyes or pigments), chelating agents, abrasives, bleaching agents, and so forth.

The content of water, the medium, in the aqueous detergent, is preferably 50 to 99.9% by weight, particularly 80 to 99% by weight, in view of detergency and finish.

The amount of the aqueous detergent to be infiltrated into the cleaning sheet 1 is preferably 50 to 1000% by weight, particularly 100 to 500% by weight, based on the dry weight of the cleaning sheet 1 in terms of performance in removing caked-on soils, such as denatured oil, baked substances, and scale in a kitchen, and sebum, scale, soap scum, dust in a bathroom.

A second embodiment of the present invention will be illustrated with reference to Fig. 2. The second embodiment will be described in terms of differences from the first one. Otherwise the description about the first embodiment applies appropriately. The same members as in Fig. 1 are given the same numerals as used in Fig. 1.

The cleaning sheet 1 shown in Fig. 2 is a double layered unitary laminate composed of a liquid retentive sheet 4 comprising cellulosic fiber 3 and an air-laid nonwoven fabric 5 comprising thick thermoplastic fiber 2. The air-laid nonwoven fabric 5 serves as a cleaning surface as hereinafter described. The liquid retentive sheet 4 functions as a retentive carrier for an aqueous detergent when the cleaning sheet 1 is used as a wet sheet. The cleaning sheet 1 according to the second embodiment

having a double layered structure, the cleaning function and the aqueous detergent holding function are performed by separate members. On the other hand, the cleaning sheet according to the first embodiment has a single layer structure serving both as a cleaning surface and an aqueous detergent holding member.

The thick thermoplastic fibers 2 constituting the air-laid nonwoven fabric 5 have the same length and fineness and are of the same material as used in the first embodiment.

The thick thermoplastic fiber 2 content in the air-laid nonwoven fabric 5 preferably ranges 30 to 100% by weight, particularly 50 to 100% by weight, especially 50 to 100% by weight, to ensure capability of removing caked-on soils, such as denatured oil, baked substances and scale in a kitchen, and sebum, scale, soap scum, dust in a bathroom. Other fibers which constitute the air-laid nonwoven fabric 5 in addition to the thick thermoplastic fiber 2 include thermoplastic fibers having a fineness of 0.5 to 5 dtex, particularly 1 to 3 dtex, and a fiber length of 2 to 15 mm, particularly 3 to 8 mm (hereinafter referred to as thin thermoplastic fibers). The content of the thin thermoplastic fibers in the air-laid nonwoven fabric 5 is preferably 1 to 50% by weight, particularly 5 to 30% by weight. The combined use of such thin thermoplastic fibers with the thick thermoplastic fibers 2 is preferred for decreasing the basis weight of the cleaning sheet 1 while retaining the scouring or scraping properties.

Where the thick thermoplastic fiber 2 is heat-fusible, such heat-fusible thick thermoplastic fiber 2 can be used in combination with heat-fusible thin thermoplastic fiber having a fineness of 0.5 to 5 dtex, particularly 1 to 3 dtex, and a length of 2 to 15 mm, particularly 3 to 8 mm. In order to prevent the thick thermoplastic fiber from falling off and to improve the scraping properties, the heat-fusible thin thermoplastic fiber is preferably used in a proportion of 1 to 50% by weight, particularly 5 to 30% by weight. Crimping thin thermoplastic fiber which is capable of crimping in the form of a spiral, a zig-zag, a U-shape, etc. is preferably used to improve the bulkiness and thereby the feel on use of the cleaning sheet 1.

The air-laid nonwoven fabric 5 preferably has a basis weight of 30 to 200 g/m^2,

particularly 50 to 150 g/m^2, to secure capability of removing caked-on soils in a kitchen or a bathroom.

There exist a great number of the tips of the thick thermoplastic fibers 2 on the surface of the air-laid nonwoven fabric in nature of the air-lay method. In the second embodiment, it is this surface that serves as a cleaning surface of the cleaning sheet 1, with which soils can be scoured or scraped off from a soiled surface.

The fiber length of the cellulosic fibers 3 constituting the liquid retentive sheet 4 is selected appropriately according to the sheet forming method. Where the liquid retentive sheet 4 is formed by wet papermaking, for example, it is preferred for the cellulosic fibers 3 to have a length of 0.1 to 20 mm, particularly 0.2 to 15 mm. Where the sheet 4 is formed by spun lacing or thermal bonding, the fiber length of the cellulosic fibers 3 is preferably 30 to 100 mm, particularly 35 to 65 mm. Where the sheet 4 is formed by air laying, the fiber length is preferably 0.1 to 15 mm, particularly 0.3 to 10 mm. Examples of the cellulosic fibers 3 are the same as those enumerated for the first embodiment.

The cellulosic fiber 3 content in the liquid retentive sheet 4 preferably ranges 30 to 100% by weight, particularly 50 to 100% by weight, to ensure capability of retaining a liquid detergent and absorbing a dirty liquid. Other fibers which can constitute the liquid retentive sheet 4 in addition to the cellulosic fiber 3 include heat-fusible fiber having a fineness of 0.5 to 5 dtex, particularly 1 to 3 dtex, and a length of 2 to 15 mm, particularly 3 to 8 mm. The heat-fusible fiber is preferably used in a proportion of 5 to 70% by weight, particularly 10 to 50% by weight, in the liquid retentive sheet 4. Where, in particular, the air-laid nonwoven fabric 5 contains heat-fusible fiber or heat-fusible powder, it is preferred to use the heat-fusible fiber as a constituent of the liquid retentive sheet 4 to ensure bonding between the air-laid nonwoven fabric 5 and the liquid retentive sheet 4. Useful heat-fusible fibers include low-melting polyolefin fibers, polyester fibers, the above-described conjugate fibers composed of a low-melting resin and a high-melting resin, the low-melting resin forming at least part of the fiber surface.

The cleaning sheet 1 according to the second embodiment comprises 10 to 90% by weight, preferably 20 to 80% by weight, of the thick thermoplastic fibers and 10 to 90% by weight, preferably 20 to 80% by weight, of the cellulosic fibers. These contents and the preference are based on the same reasons as described previously.

The cleaning sheet 1 of the second embodiment can be prepared, for example, according to the following methods (1) to (3).

(1) A web comprising the cellulosic fibers 3 having a fiber length of 0.1 to 15 mm is formed by an air-lay method, and the constituent fibers are bonded by fusion or with a binder at their intersections to form a liquid retentive sheet 4. Separately, a web comprising the thick thermoplastic fibers 3 is formed by an air-lay method, and the constituent fibers are bonded by fusion or with a binder at their intersections to form an air-laid nonwoven fabric 5. The air-laid nonwoven fabric 5 is superposed on one side of the liquid retentive sheet 4, and the two layers are united into one body by, for example, fusion bonding by heat embossing or ultrasonic embossing or with a hot-melt adhesive.

(2) A web comprising the cellulosic fibers 3 having a fiber length of 0.1 to 15 mm is formed by an air-lay method, and the constituent fibers are bonded by fusion or with a binder at their intersections to form a liquid retentive sheet 4. An air-laid web comprising the thick thermoplastic fibers 2 is superposed on one side of the liquid retentive sheet 4. The fibers constituting the web are bonded by fusion or with a binder at their intersections to make the web into an air-laid nonwoven fabric 5 and, at the same time, the two layers are bonded together into one body by fusion or with a binder. Fusion by heat embossing or ultrasonic embossing is effective to secure firm bonding of the two layers.

(3) An air-laid web comprising the thick thermoplastic fibers 2 is superposed on one side of an air-laid web comprising the cellulosic fibers 3 having a fiber length of 0.1 to 15 mm. The fibers constituting each web are bonded among themselves at their intersections by fusion or with a binder and, at the same time, the two webs were bonded together by fusion or with a binder thereby to form a liquid retentive sheet 4 and

an air-laid nonwoven fabric 5 which are united into one body. The means for uniting is the same as in the methods (1) and (2).

Fig. 3 schematically illustrates the cleaning sheet 1 of laminate type prepared by any of the above described methods which has been heat-embossed in a rhombic lattice pattern to form a large number of straight depressions 6 while raising diamond-shaped areas 7 surrounded by the depressions 6. The depressed areas 6 are made denser by heat and pressure application of embossing than the raised areas 7. The pattern of the depressions 6 is not limited to the lattice as shown and includes stripes, dots and other arbitrary designs. For obtaining both the surface strength withstanding a cleaning operation and the cleaning performance, the total area ratio of the depressions 6 is preferably 5 to 50%, particularly 10 to 40%, based on the cleaning surface area of the cleaning sheet 1.

Similarly to the first embodiment, the cleaning sheet 1 according to the second embodiment can be used as either a dry sheet or a wet sheet.

The mechanism of soil removal with the cleaning sheet 1 according to the second embodiment is almost the same as in the case of the first embodiment. The air-laid nonwoven fabric 5 side of the cleaning sheet 1 is applied to a soiled surface and rubbed to supply an aqueous detergent held in the liquid retentive sheet 4 to the soiled surface through the air-laid nonwoven fabric 5. The soils on the soiled surface are swollen, dissolved or floated by the detergent and, at the same time, scoured or scraped by a large number of the tips of the thick thermoplastic fibers 2 present on the air-laid nonwoven fabric 5. The soils are thus removed from the soiled surface through these chemical and mechanical actions. The soils thus caught up are dissolved or dispersed in the aqueous detergent and absorbed by the liquid retentive sheet 4 together with the detergent to make the surface clean.

The present invention is not limited to the above-described embodiments. For instance, the cleaning sheet of the second embodiment may have the air-laid nonwoven fabric 5 on both sides of the liquid retentive sheet 4, in which case both sides of the cleaning sheet avail for cleaning.

In the cleaning sheet of the first embodiment, the thick thermoplastic fibers may be distributed with a gradient in the thickness direction by appropriately controlling the air-lay conditions. For example, as shown in Fig. 4, the cleaning sheet 1 can have the thick thermoplastic fibers in a larger amount in one side thereof than in the other side. In this case, it is preferred that the side having a larger amount of the thick thermoplastic fibers be used as a cleaning surface.

It is possible to produce the cleaning sheet 1 according to any of the above-described embodiments by a wet papermaking technique. For example, the cleaning sheet of the first embodiment can be produced as follows. A paper stock comprising heat-fusible thick thermoplastic fiber, cellulosic fiber (e.g., pulp), and a prescribed amount of a wet strength agent (e.g., a polyamide-epichlorohydrin resin) is made into a web by papermaking and dried in a drier where the thick thermoplastic fibers are fusion-bonded together at their intersections. In using high-melting thick thermoplastic fiber, a binder can be added to the stock in the same manner as in an air-lay method to provide a high-strength cleaning sheet which is prevented from dropping the constituent fibers. A schematic cross-sectional view of the cleaning sheet of the first embodiment which is prepared by the papermaking technique is shown in Fig. 5. Compared with the structure built up by an air-lay method (see Fig. 1), the thick thermoplastic fibers tend to be oriented in the planar direction.

Where the cleaning sheet according to the second embodiment is prepared by the papermaking method, a sheet comprising the thick thermoplastic fiber and a sheet comprising the cellulosic fiber are prepared separately, and the two sheets are bonded together by heat embossing or adhesion with a hot-melt adhesive.

The present invention will now be illustrated in greater detail with reference to Examples. The following Examples are presented as being exemplary of the present invention and should not be construed as being limiting.

EXAMPLE 1

(1) Pulp fiber (length-weighted average fiber length: 2.5 mm) as cellulosic fiber and (2) crimping low-melting conjugate fiber having a core/sheath structure composed

of a polyethylene terephthalate core and a polyethylene sheath (fineness: 2.2 dtex; length: 5 mm; melting point of sheath: 130°C) as heat-fusible thermoplastic fiber were mixed at a weight ratio of 60/40, and the mixed fiber was air-laid into a web. The constituent fibers of the web were bonded at their intersections with a binder (acrylonitrile-butadiene rubber) to prepare a first air-laid nonwoven fabric (dry pulp sheet) having the basis weight shown in Table 2 below as a liquid retentive sheet.

Separately, crimping low-melting conjugate fiber having a core/sheath structure composed of a polypropylene core and a polyethylene sheath (fineness: 11 dtex; length: 5 mm; melting point of sheath: 130°C) as thick thermoplastic fiber was air-laid into a web having a basis weight of 50 g/m^2. The constituent fibers were heat-fusion bonded at their intersections to obtain a second air-laid nonwoven fabric, whose particulars are shown in Table 2.

The second air-laid nonwoven fabric was put on the first air-laid nonwoven fabric, and the two sheets were fusion-bonded by heat embossing to obtain a cleaning sheet having the basis weight shown in Table 2. The resulting cleaning sheet had the structure shown in Fig. 2, having a large number of the tips of the thick thermoplastic fibers exposed on the surface of the second air-laid nonwoven fabric. The embossed pattern was a combination of a lattice and dots as shown in Fig. 6. The area ratio of the depressions was 17%.

EXAMPLE 2

A cleaning sheet having the basis weight shown in Table 2 was obtained in the same manner as in Example 1, except that the thick thermoplastic fiber of the second air-laid nonwoven fabric had a fineness of 20 dtex. The resulting cleaning sheet had the structure shown in Fig. 2, having a large number of the tips of the thick thermoplastic fibers exposed on the surface of the second air-laid nonwoven fabric.

EXAMPLE 3

A cleaning sheet having the basis weight shown in Table 2 was obtained in the same manner as in Example 1, except for changing the fineness of the thick thermoplastic fiber of the second air-laid nonwoven fabric to 35 dtex and changing the

basis weight of the second air-laid nonwoven fabric to 70 g/m^2. The resulting cleaning sheet had the structure shown in Fig. 2, having a large number of the tips of the thick thermoplastic fibers exposed on the surface of the second air-laid nonwoven fabric.

EXAMPLE 4

A cleaning sheet having the basis weight shown in Table 2 was obtained in the same manner as in Example 1, except for using, as a material of the second air-laid nonwoven fabric, a 90/10 mixture of the same crimping core/sheath type conjugate fiber as used in Example 1 but having a fineness of 72 dtex (thick thermoplastic fiber) and the same crimping core/sheath type conjugate fiber as used in Example 1 but having a fineness of 1.7 dtex (thin thermoplastic fiber). The resulting cleaning sheet had the structure shown in Fig. 2, having a large number of the tips of the thick thermoplastic fibers exposed on the surface of the second air-laid nonwoven fabric.

EXAMPLE 5

A cleaning sheet having the basis weight shown in Table 2 was obtained in the same manner as in Example 4, except that the second air-laid nonwoven fabric had a basis weight of 80 g/m^2. The resulting cleaning sheet had the structure shown in Fig. 2, having a large number of the tips of the thick thermoplastic fibers exposed on the surface of the second air-laid nonwoven fabric.

EXAMPLE 6

A cleaning sheet having the basis weight shown in Table 2 was obtained in the same manner as in Example 1, except for using, as a material of the second air-laid nonwoven fabric, a 90/10 mixture of the same crimping core/sheath type conjugate fiber as used in Example 1 but having a fineness of 100 dtex (thick thermoplastic fiber) and the same crimping core/sheath type conjugate fiber as used in Example 1 but having a fineness of 1.7 dtex (thin thermoplastic fiber). The resulting cleaning sheet had the structure shown in Fig. 2, having a large number of the tips of the thick thermoplastic fibers exposed on the surface of the second air-laid nonwoven fabric.

EXAMPLE 7

A cleaning sheet having the basis weight shown in Table 2 was obtained in the same manner as in Example 1, except for using, as a material of the second air-laid nonwoven fabric, a 50/50 mixture of nylon fiber having a fineness of 72 dtex (thick thermoplastic fiber) and the same crimping core/sheath type conjugate fiber as used in Example 1 but having a fineness of 1.7 dtex (thin thermoplastic fiber), bonding the fibers constituting the resulting web at their intersections by means of heat fusion and with a binder (acrylonitrile-butadiene rubber), and changing the basis weight of the second air-laid nonwoven fabric to 104 g/m^2. The resulting cleaning sheet had the structure shown in Fig. 2, having a large number of the tips of the thick thermoplastic fibers exposed on the surface of the second air-laid nonwoven fabric.

EXAMPLE 8

A cleaning sheet having the basis weight shown in Table 2 was obtained in the same manner as in Example 7, except that the thick thermoplastic fiber in the second air-laid nonwoven fabric was acrylic fiber having a fineness of 33 dtex. The resulting cleaning sheet had the structure shown in Fig. 2, having a large number of the tips of the thick thermoplastic fibers exposed on the surface of the second air-laid nonwoven fabric.

EXAMPLE 9

A cleaning sheet having the basis weight shown in Table 2 was obtained in the same manner as in Example 1, except for using, as a material of the second air-laid nonwoven fabric, a 90/10 mixture of crimping core/sheath type conjugate fiber having a fineness of 72 dtex and composed of a polyester core and a polyethylene sheath (thick thermoplastic fiber) and the same crimping core/sheath type conjugate fiber as used in Example 1 but having a fineness of 1.7 dtex (thin thermoplastic fiber). The resulting cleaning sheet had the structure shown in Fig. 2, having a large number of the tips of the thick thermoplastic fibers exposed on the surface of the second air-laid nonwoven fabric.

EXAMPLE 10

A cleaning sheet having the basis weight shown in Table 2 was obtained in the same manner as in Example 9, except that the second air-laid nonwoven fabric had a basis weight of 50 g/m^2. The resulting cleaning sheet had the structure shown in Fig. 2, having a large number of the tips of the thick thermoplastic fibers exposed on the surface of the second air-laid nonwoven fabric.

EXAMPLE 11

A cleaning sheet having the basis weight shown in Table 2 was obtained in the same manner as in Example 1, except that a second air-laid nonwoven fabric having a basis weight of 80 g/m^2 was prepared from crimping core/sheath type conjugate fiber having a fineness of 22 dtex and composed of a polyethylene terephthalate core and a low-melting polyester sheath (thick thermoplastic fiber; melting point of sheath: 110°C). The resulting cleaning sheet had the structure shown in Fig. 2, having a large number of the tips of the thick thermoplastic fibers exposed on the surface of the second air-laid nonwoven fabric.

EXAMPLE 12

A cleaning sheet having the basis weight shown in Table 2 was obtained in the same manner as in Example 11, except for using, as a material of the second air-laid nonwoven fabric, a 75/25 mixture of crimping core/sheath type conjugate fiber composed of a polyethylene terephthalate core and a low-melting polyester sheath and having a fineness of 56 dtex (thick thermoplastic fiber; melting point of sheath: 110°C) and crimping core/sheath type conjugate fiber composed of a polyethylene terephthalate core and a low-melting polyester sheath and having a fineness of 2.2 dtex (thin thermoplastic fiber; melting point of sheath: 110°C). The resulting cleaning sheet had the structure shown in Fig. 2, having a large number of the tips of the thick thermoplastic fibers exposed on the surface of the second air-laid nonwoven fabric.

EXAMPLE 13

A cleaning sheet having the basis weight shown in Table 2 was obtained in the same manner as in Example 11, except for using, as a material of the second air-laid

nonwoven fabric, a 30/70 mixture of crimping core/sheath type conjugate fiber composed of a polyethylene terephthalate core and a low-melting polyester sheath and having a fineness of 56 dtex (thick thermoplastic fiber; melting point of sheath: 110°C) and crimping core/sheath type conjugate fiber composed of a polyethylene terephthalate core and a low-melting polyester sheath and having a fineness of 22 dtex (thick thermoplastic fiber; melting point of sheath: 110°C). The resulting cleaning sheet had the structure shown in Fig. 2, having a large number of the tips of the thick thermoplastic fibers exposed on the surface of the second air-laid nonwoven fabric.

COMPARATIVE EXAMPLE 1

Two sheets of the first air-laid nonwoven fabric (dry pulp sheet) prepared in Example 1 were fusion-bonded together by heat embossing in the same manner as in Example 1 to obtain a cleaning sheet having the basis weight shown in Table 2.

EXAMPLE 14

The same crimping core/sheath type conjugate fiber having a fineness of 72 dtex as used in Example 5 as thick thermoplastic fiber and pulp fiber (length-weighted average fiber length: 2.5 mm) as cellulosic fiber were mixed at a weight ratio of 70/30 and air-laid into a web having the basis weight shown in Table 3. The constituent fibers of the web were bonded at their intersections by fusion and with a binder (acrylonitrile-butadiene rubber) to prepare a cleaning sheet having the basis weight shown in Table 3. The resulting cleaning sheet had the structure shown in Fig. 4, having a large number of the tips of the thick thermoplastic fibers exposed on the surface thereof.

EXAMPLE 15

The same acrylic fiber as used in Example 8 (fineness: 33 dtex) as thick thermoplastic fiber and pulp fiber (weighted average fiber length: 2.5 mm) as cellulosic fiber were mixed at a weight ratio of 70/30. The mixed fiber was mixed with 0.6% by weight of a wet strength agent (polyamide-epichlorohydrin), and the resulting stock was made into a sheet having a basis weight of 100 g/m^2 by a manual papermaking method. The constituent fibers were bonded at their intersections with a binder (acrylonitrile-butadiene rubber) to obtain a cleaning sheet having the basis weight shown in Table 3.

The resulting cleaning sheet had the structure shown in Fig. 5, having a large number of the tips of the thick thermoplastic fibers exposed on its surface.

COMPARATIVE EXAMPLE 2

Crimping core/sheath type conjugate fiber composed of a polyethylene terephthalate core and a low-melting polyester sheath (fineness: 2.2 dtex; length: 5 mm) and pulp fiber (length-weighted average length: 2.1 mm) as cellulosic fiber were mixed at a ratio of 10/90. The mixed fiber was mixed with 0.6% of a wet strength agent (polyamide-epichlorohydrin), and the resulting stock was made into paper having a basis weight of 30 g/m^2 by a conventional papermaking machine. Two sheets of the paper thus prepared were fusion-bonded together by heat embossing to obtain a cleaning sheet having the basis weight shown in Table 3.

COMPARATIVE EXAMPLE 3

A brush made of a metal (BONSTAR SOAP PAD available from NIHON STEEL WOOL) was used in comparative example 3.

COMPARATIVE EXAMPLE 4

A sponge with abrasive particles (SCOTCH BRIGHT available from SUMITOMO 3M) was used in comparative example 4. This sponge has a surface made of nonwoven fabric with abrasive particles which surface serves as a cleaning surface.

Evaluation of performance:

The cleaning sheets prepared in the foregoing Examples and Comparative Examples were evaluated for performance in removing simulated caked-on soils (a), (b) and (c) prepared as follows. The evaluation was made in terms of soil removal ratio measured as follows. In addition, prevention of scratch was evaluated for the following method. The results obtained are shown in Tables 2 to 4.

1) Preparation of slightly denatured oil

Salad oil (0.06 g) was uniformly spread on a sandpapered iron plate (30 mm by

80 mm) and baked at 160°C for 30 minutes to make slightly denatured oil soil, the pencil hardness of which was 6B or softer (designated soil (a)).

2) Preparation of medium-denatured oil

Salad oil (0.06 g) was uniformly spread on a sandpapered iron plate (30 mm by 80 mm) and baked at 150°C for 130 minutes to make medium-denatured oil soil, the pencil hardness of which was 2B to 3B (designated soil (b)).

3) Preparation of burnt-on soil

A mixture (0.06 g) of sugar/soy sauce/*mirin* (sweet *sake* for cooking) in a weight ratio of 40/44/16 was uniformly spread on a SUS304 plate (30 mm by 80 mm) and baked at 180°C for 120 minutes to prepare burnt-on soil, the pencil hardness of which was 9H (designated soil (c)).

4) Measurement of soil removal ratio

The cleaning sheet was impregnated with 200% (based on the dry cleaning sheet) of an aqueous detergent having the formulation shown in Table 1. The soil prepared above was given 50 double strokes of rubbing with the cleaner-impregnated sheet by hand.

TABLE 1

Formulation of aqueous detergent

Water	94.59%
Dodecyl glucoside (condensation degree: 1.4; surface active agent)	0.2%
Alkylbenzylammonium chloride (antimicrobial agent)	0.01%
Propylene glycol (water-soluble solvent)	5%
Trisodium citrate (electrolyte)	0.2%

The weight of the test piece before being soiled (weight B) was subtracted from the weight of the soiled test piece (weight A) to obtain the weight of the soil attached. After being cleaned with the cleaning sheet, the test piece was lightly washed with water, dried, and weighed (weight C). The soil removal ratio (%) was calculated from equation:

Soil removal ratio (%) = [(A - C)/(A - B)] x 100

5) Prevention of scratch

The cleaning sheet was impregnated with 200% (based on the dry cleaning sheet) of an aqueous detergent having the formulation shown in Table 1 above. A stainless plate, an artificial marble plate and a fluorine resin plate (30mm x 80mm) were given 20 double strokes of rubbing respectively with the cleaner-impregnated sheet by hand. The degree of the prevention of scratch was evaluated for the following rank.

A: no scratch was observed

B: scratch was observed when lighted up

C: scratch was observed slightly

D: scratch was observed considerably

TABLE 2

	Second Air-laid Nonwoven Fabric							First Air-laid Nonwoven Fabric		Cleaning Sheet						
	Thick Thermoplastic Fiber			Thin Thermoplastic Fiber			Binder	Pulp/ Heat-fusible Fiber (60/40)	Binder	Basis Weight (g/m^2)	Soil Removal Ratio (%)			Prevention of Scratch		
	Length (mm)	Fineness (dtex)	Basis Weight (g/m^2)	Length (mm)	Fineness (dtex)	Basis Weight (g/m^2)	Basis Weight (g/m^2)	Basis Weight (g/m^2)	Basis Weight (g/m^2)		Soil (a)	Soil (b)	Soil (c)	Stainless (SUS304)	Artificial Marble	Fluorine Resin
Example 1	5	11	50	—	—	—	—	70	10	130	86	9	27	A	A	A
Example 2	5	20	50	—	—	—	—	70	10	130	85	10	37	A	A	A
Example 3	5	35	70	—	—	—	—	70	10	150	88	28	50	A	A	A
Example 4	5	72	45	5	1.7	5	—	70	10	130	91	58	87	A	A	A
Example 5	5	72	72	5	1.7	8	—	70	10	160	92	88	92	A	A	A
Example 6	5	100	45	5	1.7	5	—	70	10	130	88	38	60	A	A	A
Example 7	5	72	40	5	1.7	40	24	70	10	184	90	40	67	A	A	A
Example 8	5	33	40	5	1.7	40	24	70	10	184	93	87	94	A	A	A
Example 9	5	72	72	5	1.7	8	—	70	10	160	96	95	95	A	A	A
Example 10	5	72	45	5	1.7	5	—	70	10	130	95	88	90	A	A	A
Example 11	5	22	80	—	—	—	—	70	10	160	97	100	100	A	A	A
Example 12	5	56	60	5	2.2	20	—	70	10	160	99	100	100	A	A	A
Example 13	5	22 (70%) 56 (30%)	80	—	—	—	—	70	10	160	97	100	100	A	A	A
Comparative Example 1	—	—	—	—	—	—	—	140	20	160	40	4	23	A	A	A

TABLE 3

	Thick Thermoplastic Fiber			Cellulosic Fiber	Binder	Cleaning Sheet	Soil Removal Ratio (%)			Prevention of Scratch		
	Length (mm)	Fineness (dtex)	Basis Weight (g/m^2)	Basis Weight (g/m^2)	Basis Weight (g/m^2)	Basis Weight (g/m^2)	Soil (a)	Soil (b)	Soil (c)	Stainless (SUS304)	Artificial Marble	Fluorine Resin
Example 14	5	72	84	36	10	130	90	88	90	A	A	A
Example 15	5	33	70	30	15	115	86	52	85	A	A	A
Comparative Example 2	5	2.2	6	54	–	60	40	4	22	A	A	A

TABLE 4

	Soil Removal Ratio (%)			Prevention of Scratch		
	Soil (a)	Soil (b)	Soil (c)	Stainless (SUS304)	Artificial Marble	Fluorine Resin
Comparative Example 3	99	100	100	D	D	D
Comparative Example 4	100	100	100	D	D	D

The results in Tables 2 to 4 apparently prove that the cleaning sheets of Examples according to the present invention are excellent in scouring or scraping performance against various soils. In addition, the cleaning sheets of Examples which contains the specific thick thermoplastic fibers do not make a scratch on the surface to be cleaned.

As described and demonstrated above, the cleaning sheet of the present invention exhibits sufficient scouring or scraping properties against soils. In addition, the cleaning sheet of the present invention does not make a scratch on a surface to be cleaned, for example, in a kitchen and a bathroom, made of stainless, artificial marble, fluorine resin, tiles and enamel. In particular, a combined use with an aqueous detergent boosts the soil removal performance of the cleaning sheet. The cleaning sheet of the present invention is especially suited to removal of caked-on soils found in a kitchen, such as denatured oil, baked-on substances, and scale.

The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications are would be obvious to one skilled in the art are intended to included within the scope of the following claims.

This application claims the priority of Japanese Patent Application Nos. 2000-367396 filed December 1, 2000 and 2001-182619 filed June 15, 2001, which are incorporated herein by reference.